IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

TOYOSHIMA et al.

Application No. Unknown

Filed: December 14, 2001

Art Unit: Unknown

Examiner: Unknown

For: ELECTRONIC DEVICE AND COUPLER

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Prior to the examination of the above-identified patent application, please enter the following amendments and consider the following remarks.

IN THE SPECIFICATION:

Replace the paragraph beginning at page 1, line 9 with:

In a field of assembling constitutional components or elements of an electronic device, solder balls are generally used to connect a semiconductor chip (such as a silicon chip) with an organic printed circuit board to mount the semiconductor chip. The semiconductor chip has a thermal expansion coefficient of about 3 ppm/°C, whereas the organic printed circuit board has a thermal expansion coefficient as large as 20 to 60 ppm/°C. The difference in thermal expansion coefficients between the semiconductor chip and the organic printed circuit board induces stress on the electronic device with an increase in temperature. There are cases where the stress forms cracks on the solder balls used for connecting the semiconductor chip and then causes a conduction failure of the device.

Replace the paragraph beginning at page 1, line 22 with:

Various methods have been proposed to relax the stress. For example, Fig. 15 shows a method of applying a resin 3 around solder balls 2 to reinforce the connection with a semiconductor chip 1. The solder balls 2 connect pads (electrodes) 4a and 4b located face to

face. A copper wiring layer 6 is formed inside the organic printed circuit board 5 to make an electrical connection to the pad 4b.

Replace the paragraph beginning at page 2, line 12 with:

In these methods which use a resin as a reinforcing material, specific production equipment is required and a step of forming a resin layer, in addition to a step of connecting the solder balls, is necessarily employed, increasing the cost of manufacturing the device. Furthermore, in the method shown in Fig. 16, because the semiconductor chip 1 and the organic printed circuit board 5 are firmly adhered to each other and generate stress, there are cases 1) where the semiconductor chip 1 is broken, 2) where the organic printed circuit board 5 is warped and 3) where voids which are likely to be formed in the underfill layer 7 leading to cracking between the semiconductor chip 1 and the organic printed circuit board 5.

Replace the paragraph beginning at page 3, line 5 with:

Japanese Patent Laid-Open No. Hei 5-259166 discloses a method of forming a structure on an electrode of a semiconductor chip, where metal dendrites made from copper, etc., grown on the electrode, are filled up with a resin. However, this method has such problems that (1) specific production equipment different from the conventional equipment is necessarily employed, making the production process complicated and increasing the production cost, (2) it is difficult to form the metal dendrites uniformly, and (3) filling the resin among the metal dendrites is likely to form voids to deteriorate the reliability of the semiconductor chip.

Replace the paragraph beginning at page 3, line 16 with:

Japanese Patent Laid-Open No. Hei 5-275485 discloses a structure in which a metal layer has an H cross-section, the circumference of which is covered with a resin, so as to prevent the formation of bump cracks. However, it requires a lithographic process and a plating process for forming the metal layer and the resin layer, which are relatively expensive steps in manufacturing an electronic device.

Replace the paragraph beginning at page 3, line 24 with:

Japanese Patent Laid-Open No. Hei 7-312400 discloses a method which uses a thin wire as an electrode of wire bonding to form junctions, wherein the thin wire includes a core made from a resin, a ceramic or a high melting point metal and a covering of the core made

from a low melting point solder. In recent years, semiconductor chips have increased in the number of electrodes for input and output, and may reach as many as one thousand and more. The increase of electrodes in number will make it disadvantageous to form a solder layer for connecting by the wire bonding method from the standpoint of tact time of the process.

Replace the paragraphs beginning at page 6, line 4 with:

Fig. 2 is a diagram showing an appearance of a coupler.

Replace the paragraphs beginning at page 6, line 6 with:

Figs. 3A and 3B are diagrams showing a process for forming a coupler.

Replace the paragraphs beginning at page 6, line 8 with:

Figs. 4A and 4B are an elevational view and a side view, respectively, showing an appearance of a coupler.

Replace the paragraphs beginning at page 6, line 10 with:

Fig. 5 is a cross sectional view showing a structure of a resin ball.

Replace the paragraphs beginning at page 6, line 12 with:

Figs. 6A to 6C are diagrams showing a process for forming a coupler.

Replace the paragraphs beginning at page 6, line 14 with:

Figs. 7A and 7B are diagrams showing masks 31a and 31b used for exposing resin to obtain a resin ball.

Replace the paragraphs beginning at page 6, line 16 with:

Figs. 8A and 8B are an elevational view and a side view, respectively, showing an appearance of a resin ball.

Replace the paragraph beginning at page 6, line 23 with:

Fig. 11 is a diagram showing a method for fixing a coupler between electrodes (pads).

IN THE CLAIMS:

Replace the indicated claims with:

1. (Amended) An electronic device comprising:

an element-carrying-substrate having an electronic element and a first electrode, the first electrode being disposed on a surface of the element-carrying-substrate and having a first area;

a wiring substrate facing the element-carrying-substrate and having a second electrode disposed on a surface of said wiring substrate, the second electrode having a second area and facing the first electrode; and

a coupler disposed between the first electrode and the second electrode, joining the element-carrying-substrate to the wiring substrate, the coupler having a resin body, an electrically conductive member, and a surface comprising a resin region and an electrically conductive region electrically connecting the first electrode to the second electrode.

2. (Amended) The electronic device as claimed in claim 1, wherein the resin region occupies from 20 to 80% of the surface of the coupler.

3. (Amended) The electronic device as claimed in claim 1, wherein the electrically conductive member is a joining metal and the electrically conductive region includes the joining metal that is located on the surface of the coupler.

4. (Amended) The electronic device as claimed in claim 1, wherein the electrically conductive member comprises a metal powder with a high melting point and the electroconductive region includes the metal powder that is located on the surface of the coupler, the metal powder being joined to a joining metal film.

5. (Amended) The electronic device as claimed in claim 1, wherein the electrically conductive member comprises a metal strip layer joined to a joining metal film, the metal strip layer encircling the resin body as the electrically conductive region.

6. (Amended) The electronic device as claimed in claim 5, wherein the metal strip layer has an opening disposed substantially at a center of the element carrying substrate and the wiring substrate.

7. (Amended) The electronic device as claimed in claim 1, wherein the resin body is a thermosetting resin.

8. (Amended) The electronic device as claimed in claim 1, wherein the resin body is a thermoplastic resin.

9. (Amended) A coupler with a spherical shape comprising a blend of a joining metal and a resin, wherein the coupler includes a surface comprising an electrically conductive region formed by the joining metal and a resin region formed by the resin.

10. (Amended) A coupler with a spherical shape comprising a resin body and metal powder with a high melting point, the coupler having a surface comprising an electrically conductive region and a rosin region, wherein the metal powder that is located on the surface of the coupler is joined to a joining metal film to form the electrically conductive region.

11. (Amended) A coupler with a spherical shape comprising a resin ball and a metal strip layer, the metal strip layer encircling the resin ball and having an opening, wherein the metal strip layer is joined to a joining metal film.

IN THE ABSTRACT:

Replace the Abstract with:

ABSTRACT OF THE DISCLOSURE

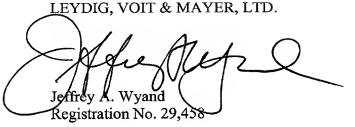
An electronic device assembled using a coupler which has an electrically conductive region and a resin region on the surface. The resilience of the resin region absorbs stress caused by a difference in thermal expansion coefficients of an organic printed circuit board and a semiconductor chip deforming the electrically conductive region. As a result, cracking in the coupler is avoided. It is preferable that the resin region occupy from 20 to 80% of the total surface area of the coupler. The coupler may be formed from a molten blend of a heat resistant resin and a joining metal. The coupler may also be formed by molding a blend of the heat resistant resin and a metal powder, wherein the metal powder located on the surface of the coupler is joined to a joining metal.

REMARKS

The foregoing Amendment corrects translational errors and conforms the claims to United States practice. No new matter is added.

Respectfully submitted,

LEYDIG, VOIT & MAYER, LTD.



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PATENT
Attorney Docket No. 401480/MELCO

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AMENDMENTS TO SPECIFICATION, CLAIMS AND ABSTRACT MADE VIA PRELIMINARY AMENDMENT

Amendments to the paragraph beginning at page 1, line 9:

In a field of assembling constitutional components or elements of an electronic device, solder balls are generally used to connect a semiconductor chip (such as a silicon chip) with an organic printed circuit board to mount the semiconductor chip. The semiconductor chip has a thermal expansion coefficient of about 3 ppm/°C, whereas the organic printed circuit board has ~~that of~~ a thermal expansion coefficient as large as 20 to 60 ppm/°C. The difference in thermal expansion ~~coefficient~~ coefficients between the semiconductor chip and the organic printed circuit board induces stress on the electronic device with ~~the~~ an increase ~~of a~~ in temperature. There are cases where the stress forms ~~cracking~~ cracks on the solder balls used for connecting the semiconductor chip and then causes a conduction failure of the device.

Amendments to the paragraph beginning at page 1, line 22:

Various methods have been proposed to relax the stress. For example, Fig. 15 shows a method of ~~filing~~ applying a resin 3 around solder balls 2 to reinforce the connection with a semiconductor chip 1. The solder balls 2 connect pads (electrodes) 4a and 4b located face to face. ~~Copper~~ A copper wiring layer 6 is formed inside the organic printed circuit board 5 to make ~~conduction with~~ an electrical connection to the pad 4b.

Amendments to the paragraph beginning at page 2, line 12:

In these methods which use a resin as a reinforcing material, specific production equipment is required and a step of forming a resin layer, in addition to a step of connecting the solder balls, is necessarily employed ~~to increase~~, increasing the cost of manufacturing the device. Furthermore, in the method shown in Fig. 16, because the semiconductor chip 1 and the organic printed circuit board 5 are firmly adhered to each other ~~to~~ and generate ~~the~~ stress, there are cases 1) where the semiconductor chip 1 is broken, 2) where the organic printed circuit board 5 is warped and 3) where voids which are likely to be formed in the underfill layer 7 ~~load~~ leading to cracking between the semiconductor chip 1 and the organic printed circuit board 5.

Amendments to the paragraph beginning at page 3, line 5:

Japanese Patent Laid-Open No. Hei 5-259166/~~1993~~ discloses a method of forming a structure on an electrode of a semiconductor chip, where metal ~~twigs~~ dendrites made from copper, etc., grown on the electrode, are filled up with a resin. However, this method has such problems that (1) specific production equipment different from the conventional ~~one~~ equipment is necessarily employed ~~to make~~, making the production process complicated and ~~increase~~ increasing the production cost, (2) it is difficult to form the metal ~~twigs~~ dendrites uniformly, and (3) filling the resin among the metal ~~twigs~~ dendrites is likely to form voids to deteriorate the reliability of the semiconductor chip.

Amendments to the paragraph beginning at page 3, line 16:

Japanese Patent Laid-Open No. Hei 5-275485/~~1993~~ discloses a structure in which a metal layer ~~is formed to have a~~ has an H cross-section, the circumference of which is covered with a resin, so as to prevent the formation of bump cracks. However, it requires a lithographic process and a plating process for forming the metal layer and the resin layer, which are relatively expensive steps in manufacturing an electronic device.

Amendments to the paragraph beginning at page 3, line 24:

Japanese Patent Laid-Open No. Hei 7-312400/~~1995~~ discloses a method which uses a thin wire as an electrode of wire bonding to form junctions, wherein the thin wire includes a core made from a resin, ~~ceramics~~ a ceramic or a high melting point metal and a covering of the core made from a low melting point solder. In recent years, ~~a~~ semiconductor ~~chip tends to increase~~ chips have increased in the number of electrodes for input and output, ~~which~~ and

may ~~reaches~~ reach as ~~large~~ many as one thousand and more. The increase of electrodes in number will make it disadvantageous to form a solder layer for connecting by the wire bonding method from the standpoint of tact time of the process.

Amendments to the paragraphs beginning at page 6, line 4:

Fig. 2 is a diagram showing an appearance of a coupler ~~20a~~.

Amendments to the paragraphs beginning at page 6, line 6:

Figs. 3A and 3B are diagrams showing a process for forming a coupler ~~20b~~.

Amendments to the paragraphs beginning at page 6, line 8:

Figs. 4A and 4B are an elevational view and a side view, respectively, showing an appearance of a coupler ~~20c~~.

Amendments to the paragraphs beginning at page 6, line 10:

Fig. 5 is a cross sectional view showing a structure of a resin ball ~~26b~~.

Amendments to the paragraphs beginning at page 6, line 12:

Figs. 6A to 6C are diagrams showing a process for forming a coupler ~~26c~~.

Amendments to the paragraphs beginning at page 6, line 14:

Figs. 7A and 7B are diagrams showing masks 31a and 31b used for exposing resin to obtain a resin ball ~~26c~~.

Amendments to the paragraphs beginning at page 6, line 16:

Figs. 8A and 8B are an elevational view and a side view, respectively, showing an appearance of a resin ball ~~26d~~.

Amendments to the paragraph beginning at page 6, line 23:

Fig. 11 is a diagram showing a method for fixing a coupler ~~20c~~ between electrodes (pads).

Amendments to existing claims:

1. (Amended) An electronic device comprising:

an element-carrying-substrate having an electronic element and a first electrode, ~~said~~ the first electrode being disposed on a surface of ~~said~~ the element-carrying-substrate and having a ~~prescribed~~ first area;

a wiring substrate ~~arranged to face said~~ facing the element-carrying-substrate and having a second electrode disposed on a surface of said wiring substrate, ~~said~~ the second electrode having a ~~prescribed~~ second area and facing ~~said~~ the first electrode; and

a coupler disposed between ~~said~~ the first electrode and ~~said~~ the second electrode ~~to join said~~, joining the element-carrying-substrate ~~and said~~ to the wiring substrate, ~~said~~ the coupler having a resin body ~~and~~, an ~~electroconductive~~ electrically conductive member, ~~the~~ and a surface ~~of said coupler~~ comprising a resin region and an ~~electroconductive~~ electrically conductive region ~~to thereby~~ electrically ~~connect said~~ connecting the first electrode ~~and said~~ to the second electrode.

2. (Amended) ~~An~~ The electronic device as claimed in claim 1, wherein the resin region occupies from 20 to 80% of the surface ~~area~~ of the coupler.

3. (Amended) ~~An~~ The electronic device as claimed in claim 1, wherein the ~~electroconductive~~ electrically conductive member is ~~formed from~~ a joining metal and the ~~electroconductive~~ electrically conductive region ~~is formed by~~ includes the joining metal ~~locating~~ that is located on the surface of the coupler.

4. (Amended) ~~An~~ The electronic device as claimed in claim 1, wherein the ~~electroconductive~~ electrically conductive member comprises a metal powder with a high melting point and the electroconductive region ~~is formed by~~ includes the metal powder ~~locating~~ that is located on the surface of the coupler, the metal powder ~~having~~ being joined to a joining metal film ~~joined thereto~~.

5. (Amended) ~~An~~ The electronic device as claimed in claim 1, wherein the ~~electroconductive~~ electrically conductive member comprises a metal strip layer ~~having~~ joined

to a joining metal film ~~joined thereto~~, the metal strip layer encircling the resin body ~~to thereby form~~ as the ~~electroconductive~~ electrically conductive region.

6. (Amended) ~~An~~ The electronic device as claimed in claim 5, wherein the metal strip layer has an opening disposed substantially at a center of the element carrying substrate and the wiring substrate.

7. (Amended) ~~An~~ The electronic device as claimed in claim 1, wherein the resin body is ~~formed from~~ a thermosetting resin.

8. (Amended) ~~An~~ The electronic device as claimed in claim 1, wherein the resin body is ~~formed from~~ a thermoplastic resin.

9. (Amended) A coupler with a spherical shape comprising a blend of a joining metal and a resin, wherein ~~the surface of said~~ the coupler ~~comprises~~ includes a surface comprising an ~~electroconductive~~ electrically conductive region formed by the joining metal ~~an~~ and a resin region formed by the resin.

10. (Amended) A coupler with a spherical shape comprising a resin body and metal powder with a high melting point, the ~~surface of the~~ coupler having a surface comprising an ~~electroconductive~~ electrically conductive region and a rosin region, wherein the metal powder ~~locating~~ that is located on the surface of the coupler ~~has~~ is joined to a joining metal film ~~joined thereto~~ to form the ~~electroconductive~~ electrically conductive region.

11. (Amended) A coupler with a spherical shape comprising a resin ball and a metal strip layer, the metal strip layer encircling the resin ~~body~~ ball and having an opening, wherein the metal strip layer ~~has~~ is joined to a joining metal film ~~joined thereto~~.

Amendments to the abstract:

ABSTRACT OF THE DISCLOSURE

An electronic device assembled using a coupler which has an ~~electroconductive~~ electrically conductive region and a resin region on the surface. ~~Flexibility~~ The resilience of the resin region absorbs stress caused by a difference in thermal expansion ~~coefficient between~~ coefficients of an organic printed circuit board and a semiconductor chip ~~through the deformation of~~ deforming the ~~electroconductive~~ electrically conductive region. As a result, ~~formation of~~ cracking in the coupler is avoided. It is preferable that the resin region ~~occupies~~ occupy from 20 to 80% of the total surface area of the coupler. The coupler may be formed

from a molten blend of ~~the~~ a heat resistant resin and a joining metal. The coupler may also be formed by molding a blend of the heat resistant resin and a metal powder, wherein the metal powder ~~locating~~ located on the surface of the coupler ~~have~~ is joined to a joining metal ~~joined thereto~~.

PATENT
Attorney Docket No. 401480/MELCO

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PENDING CLAIMS AFTER ENTRY OF PRELIMINARY AMENDMENT

1. An electronic device comprising:

an element-carrying-substrate having an electronic element and a first electrode, the first electrode being disposed on a surface of the element-carrying-substrate and having a first area;

a wiring substrate facing the element-carrying-substrate and having a second electrode disposed on a surface of said wiring substrate, the second electrode having a second area and facing the first electrode; and

a coupler disposed between the first electrode and the second electrode, joining the element-carrying-substrate to the wiring substrate, the coupler having a resin body, an electrically conductive member, and a surface comprising a resin region and an electrically conductive region electrically connecting the first electrode to the second electrode.

2. The electronic device as claimed in claim 1, wherein the resin region occupies from 20 to 80% of the surface of the coupler.

3. The electronic device as claimed in claim 1, wherein the electrically conductive member is a joining metal and the electrically conductive region includes the joining metal that is located on the surface of the coupler.

4. The electronic device as claimed in claim 1, wherein the electrically conductive member comprises a metal powder with a high melting point and the electroconductive region includes the metal powder that is located on the surface of the coupler, the metal powder being joined to a joining metal film.

5. The electronic device as claimed in claim 1, wherein the electrically conductive member comprises a metal strip layer joined to a joining metal film, the metal strip layer encircling the resin body as the electrically conductive region.

6. The electronic device as claimed in claim 5, wherein the metal strip layer has an opening disposed substantially at a center of the element carrying substrate and the wiring substrate.

7. The electronic device as claimed in claim 1, wherein the resin body is a thermosetting resin.

8. The electronic device as claimed in claim 1, wherein the resin body is a thermoplastic resin.

9. A coupler with a spherical shape comprising a blend of a joining metal and a resin, wherein the coupler includes a surface comprising an electrically conductive region formed by the joining metal and a resin region formed by the resin.

10. A coupler with a spherical shape comprising a resin body and metal powder with a high melting point, the coupler having a surface comprising an electrically conductive region and a rosin region, wherein the metal powder that is located on the surface of the coupler is joined to a joining metal film to form the electrically conductive region.

11. A coupler with a spherical shape comprising a resin ball and a metal strip layer, the metal strip layer encircling the resin ball and having an opening, wherein the metal strip layer is joined to a joining metal film.